

Quantifying the Impact of Hurricane Ian on Dune Morphology at Matanzas Inlet, Florida

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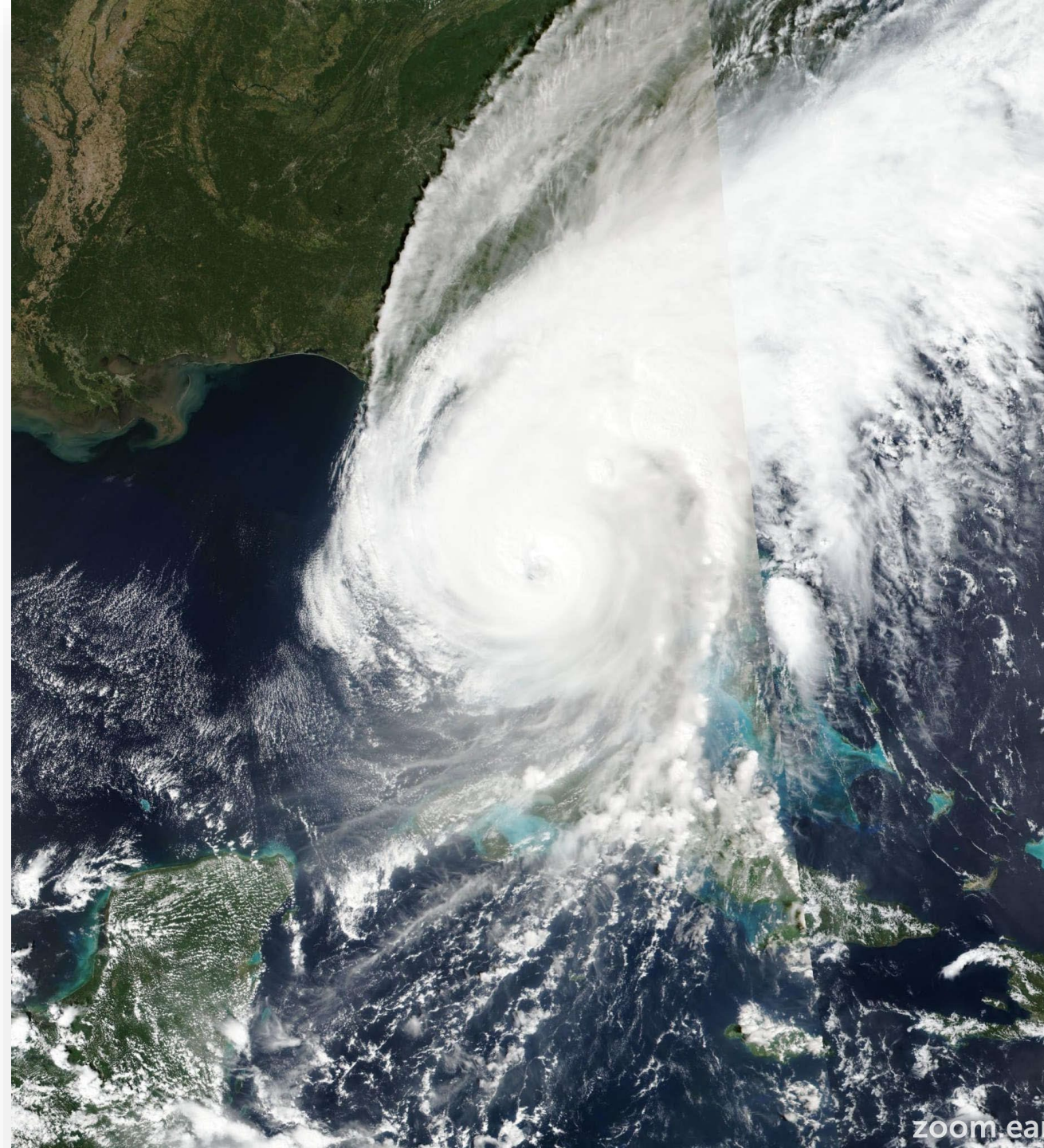
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Introduction



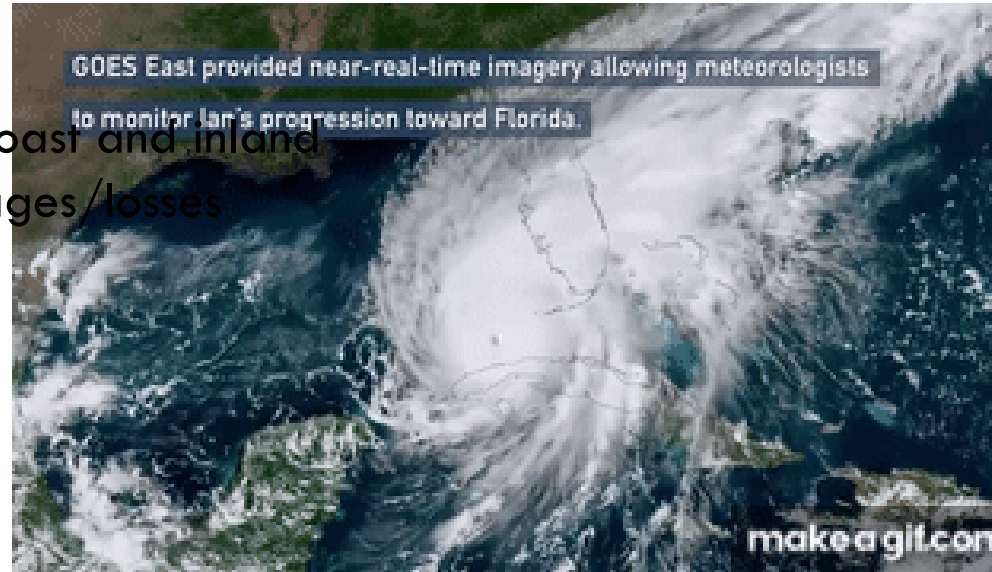
HURRICANE IAN

September 28-29, 2022

- Landfall near Fort Myers, FL as a hurricane category 4
- Crossed the Florida peninsula from the Gulf to the Atlantic coast
- 5th strongest hurricane on record to strike the U.S. (NOAA, 2022)

IMPACTS

- Widespread flooding on the coast and inland
- Casualties and property damages/losses



Introduction

Beyond (direct) impacts to society, studying hurricanes matters because...

- Hurricanes can alter shoreline position and morphology of sandy beaches
- Dunes, **the natural barriers protecting the coast against high water levels**, may retreat in response to hurricanes and not recover if two or more storms occur in close succession - decreased beach recovery time



Coastal communities and habitats become more vulnerable to coastal hazards induced by storms, and may experience negative impacts under less intense circumstances



Research Questions

1) How did Hurricane Ian impact dune morphology near Matanzas Inlet?

Quantify the impacts of Hurricane Ian on the primary coastal dunes at Matanzas Inlet, comparing pre- and post-storm beach profiles derived from digital elevation models (DEMs).

2) What is the context of the observed dune changes resulting from Ian?

Quantify the impacts of other historical hurricanes (i.e., Matthew, Irma, and Nicole) on the primary coastal dunes at Matanzas Inlet.

Study Area

Matanzas Inlet, FL

Located in St. Johns County along
the North Florida Atlantic coast

Southern end of Anastasia
Island



0 500 1,000 m

— Transects

Study Area

Wave Climate from 1980 - 2021

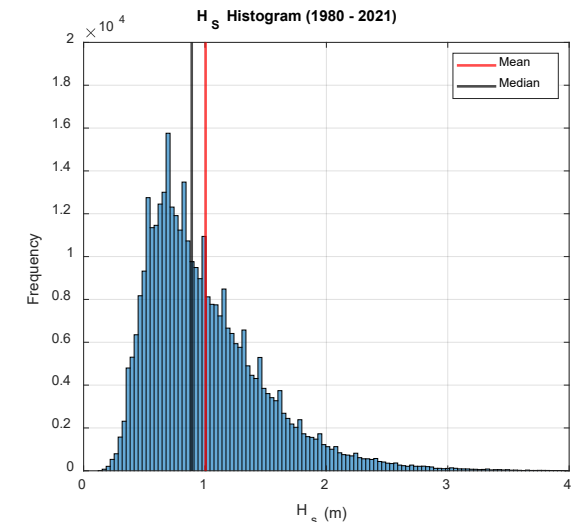
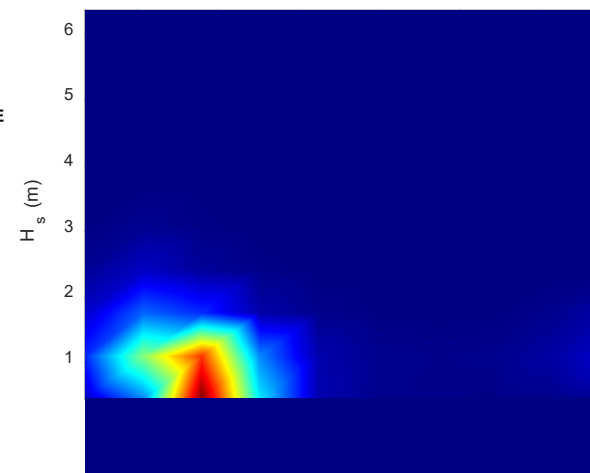
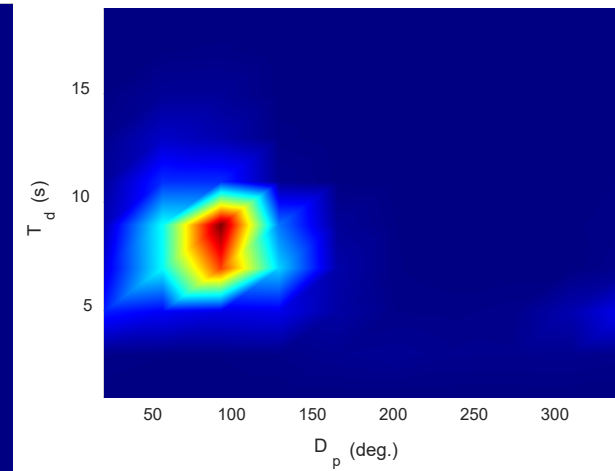
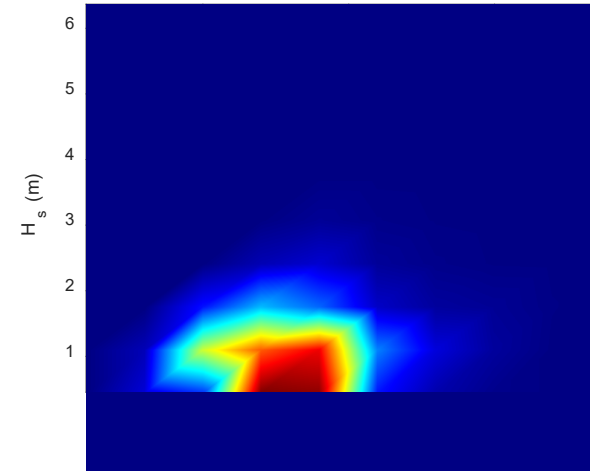
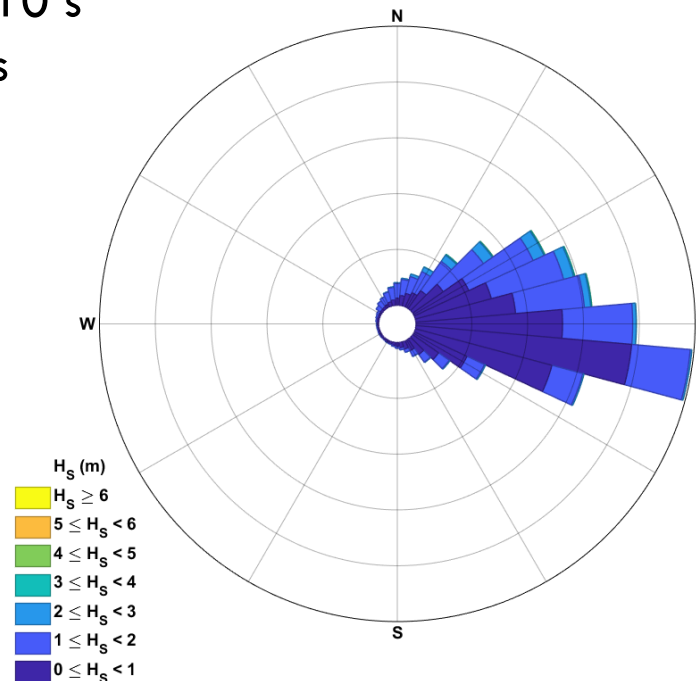
Significant Wave height (H_s)

- Winter & Spring – 1 to 1.5 m
- Summer & Fall – 0.5 to 1 m

Dominant Period (T_D)

- Winter & Spring – 7 – 10 s
- Summer & Fall – 7 – 9 s

Data source: Wave Information Studies (WIS)
Hindcast – ST 63419

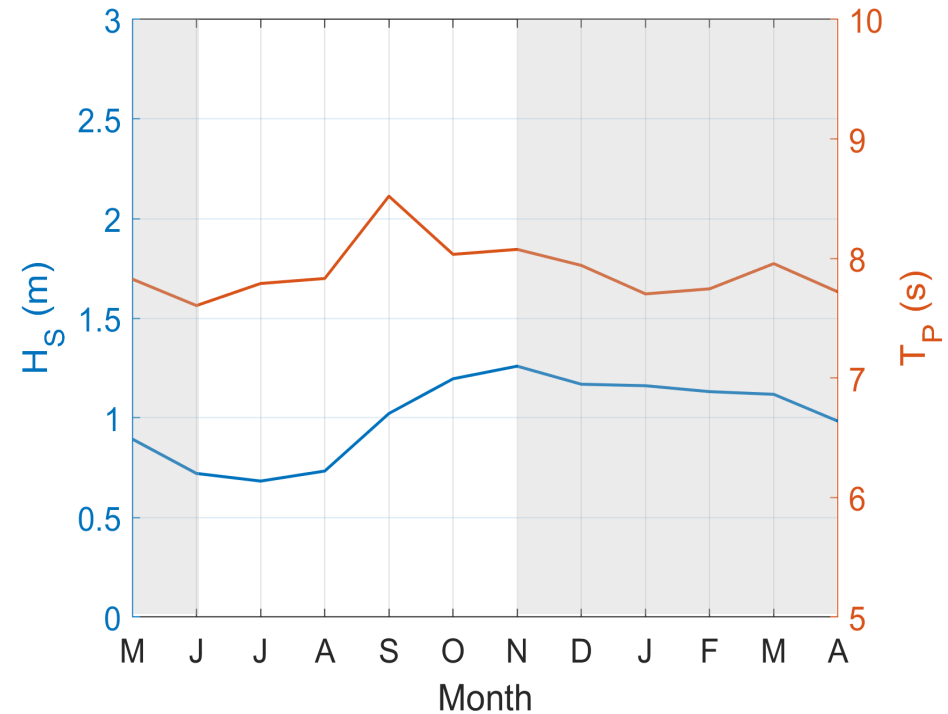


Study Area

Wave Climate from 1980 - 2021

HURRICANE SEASON

- Most energetic waves of the year
- May exacerbate beach erosion along the coast of Florida

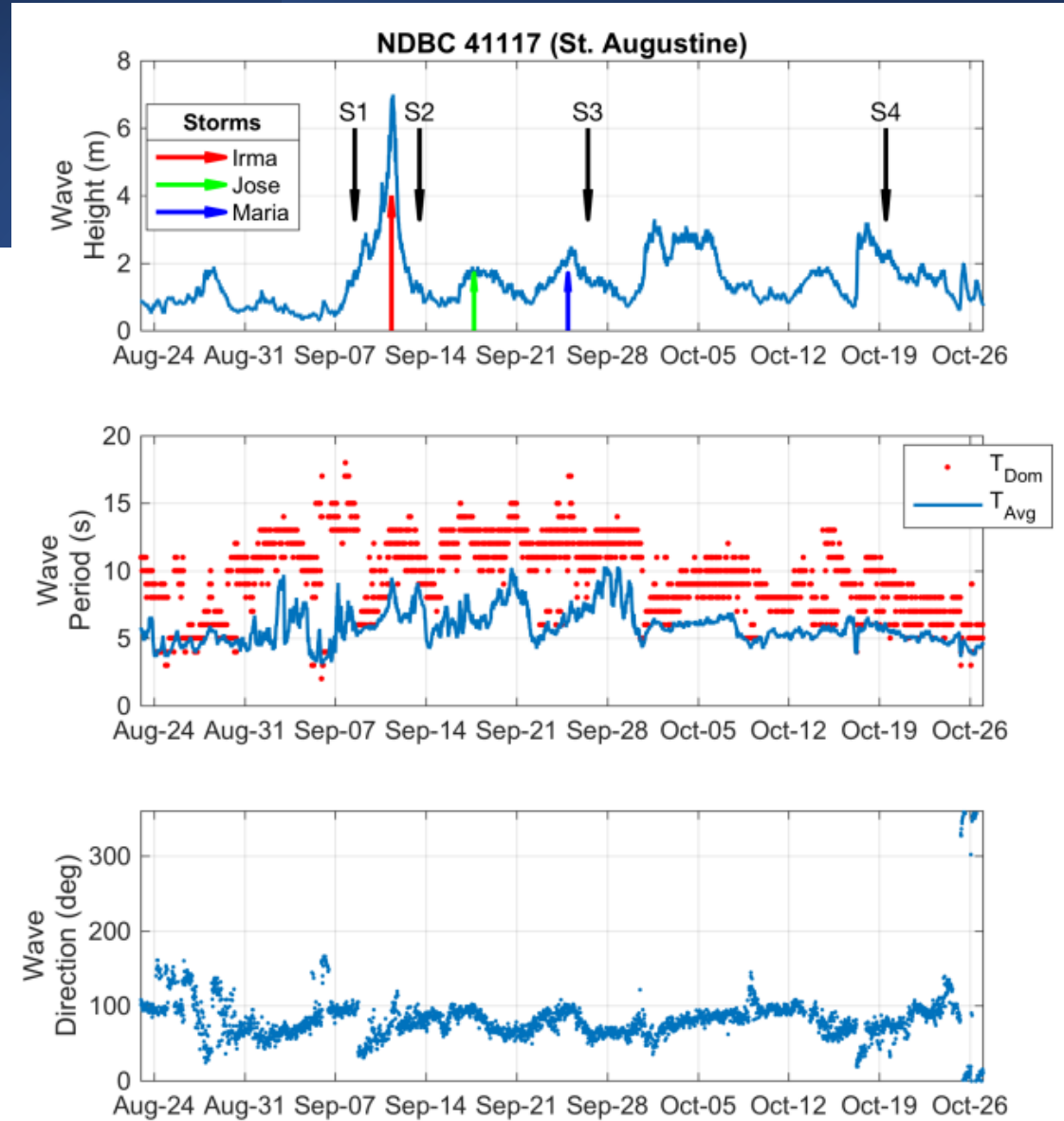
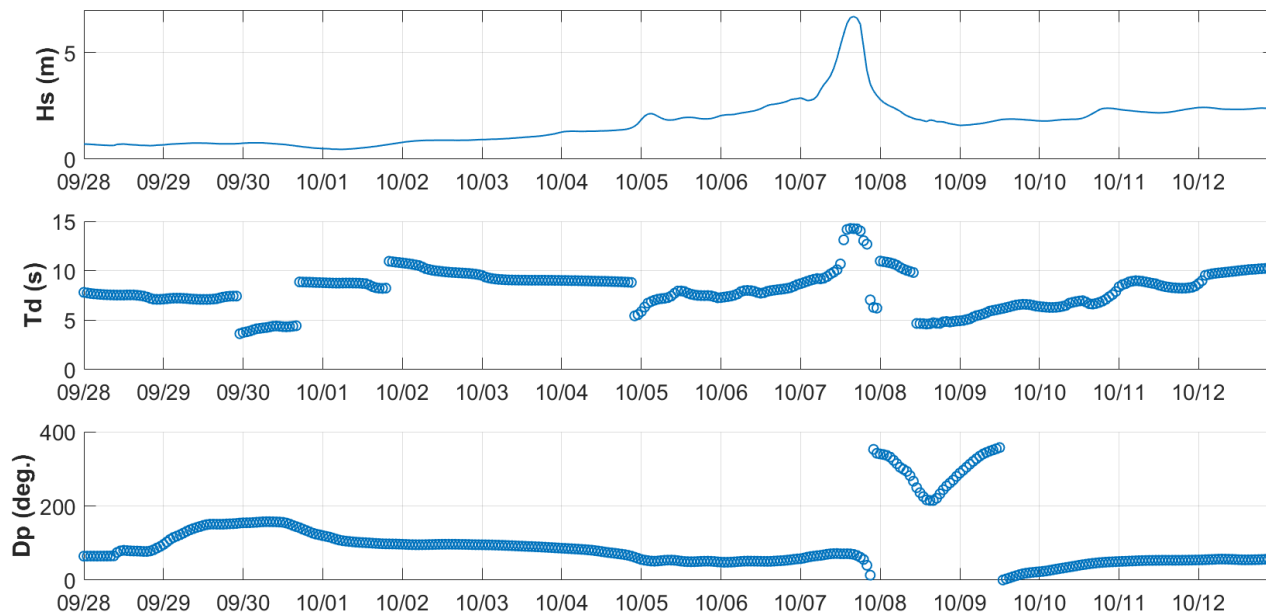


Data source: Wave Information
Studies (WIS) Hindcast – ST 63419

Study Area

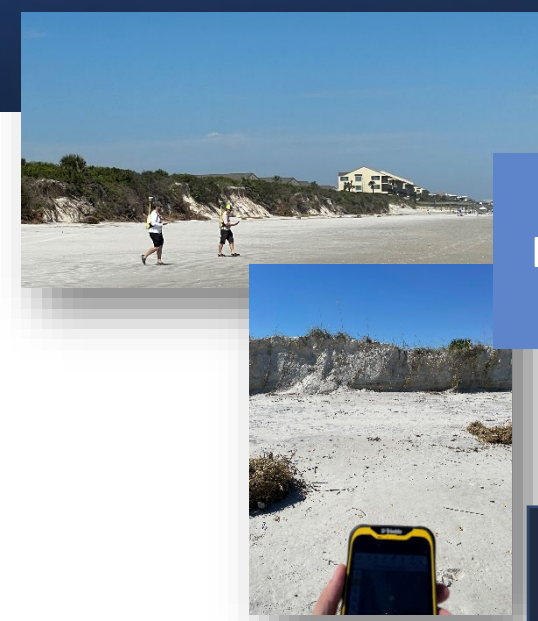
Hurricanes Matthew and Irma

Matthew - Data source: Wave Information Studies (WIS) Hindcast -ST 63419



Adams et al. (2018)

Methods



Real Time Kinematic (RTK) GPS

Fieldwork

Structure-from-Motion (SfM) Photogrammetry



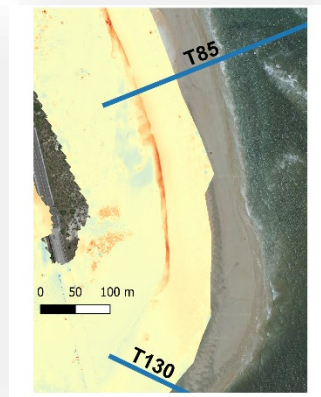
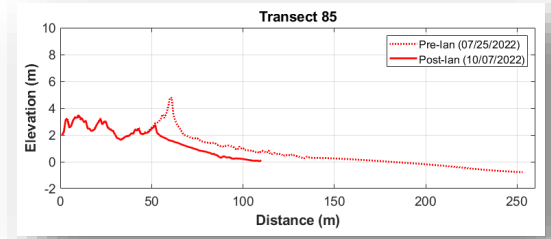
Data Processing

Metashape

Beach Profiles

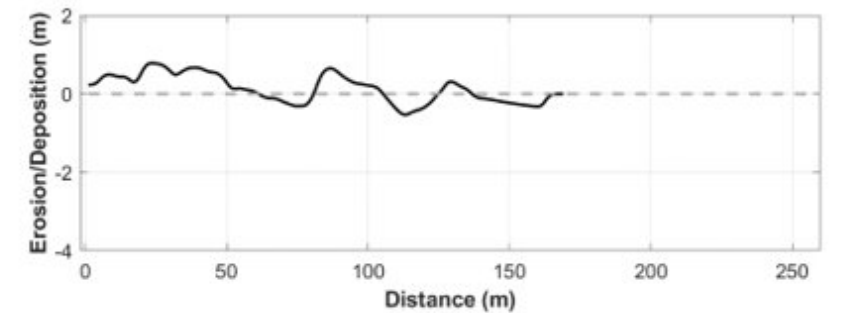
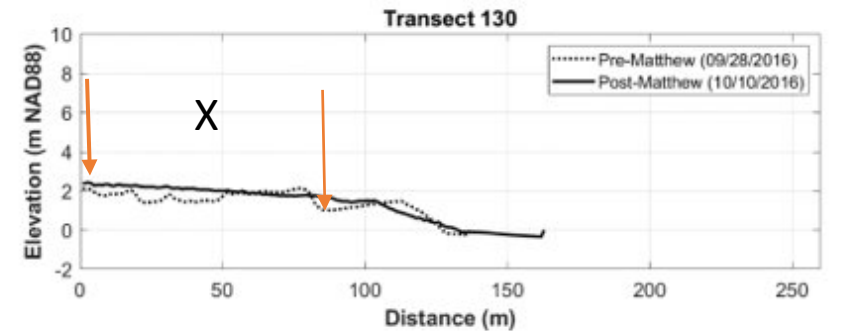
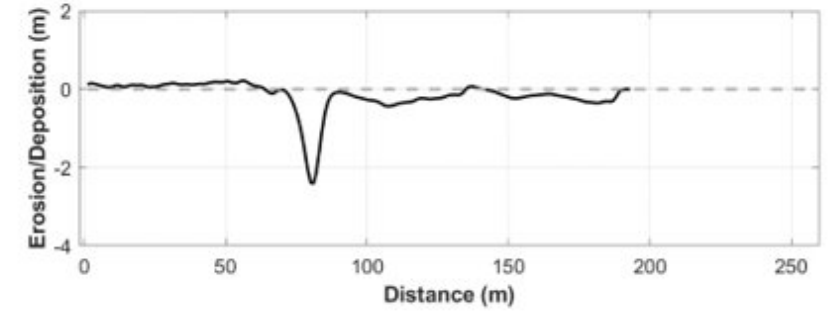
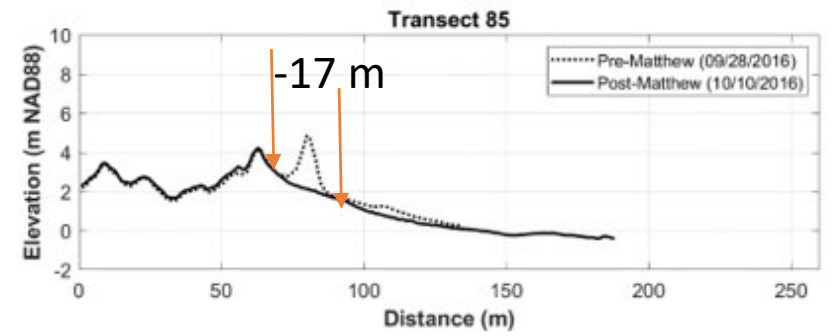
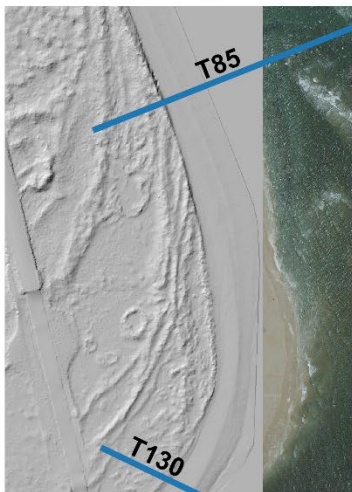
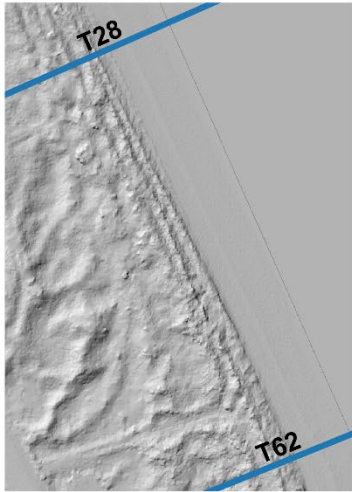
Results

Digital Elevation Models (DEMs)



Results & Discussion

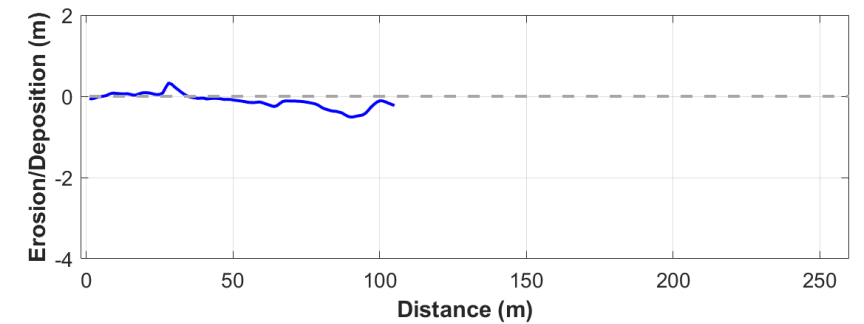
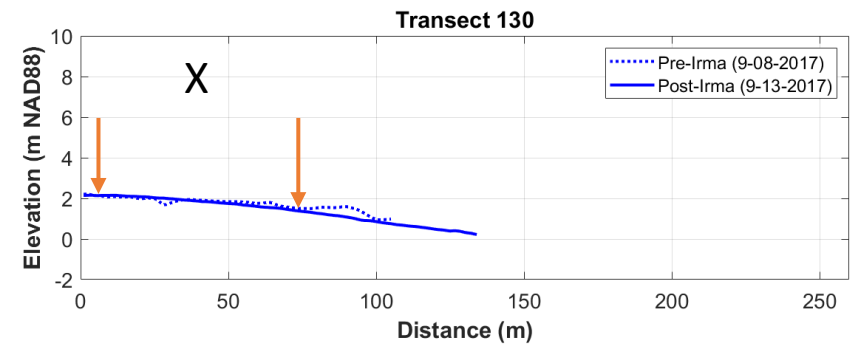
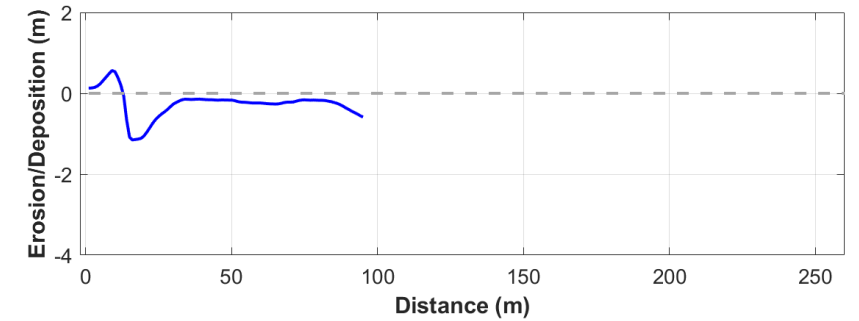
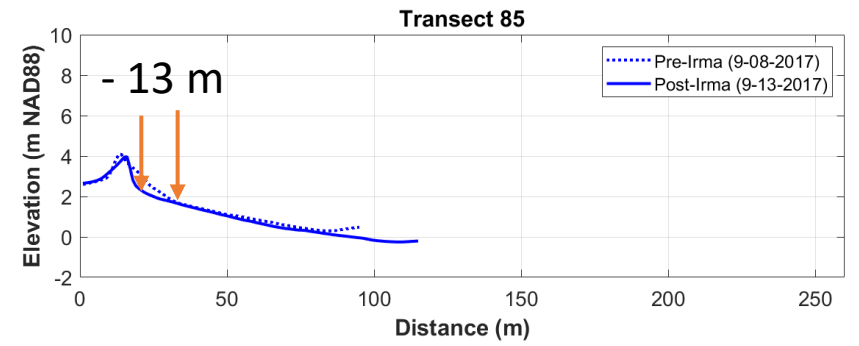
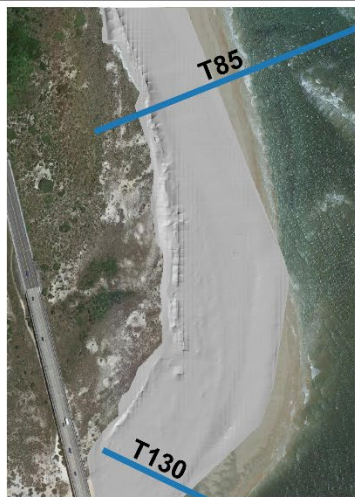
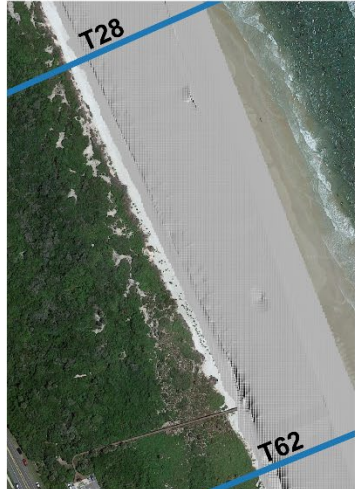
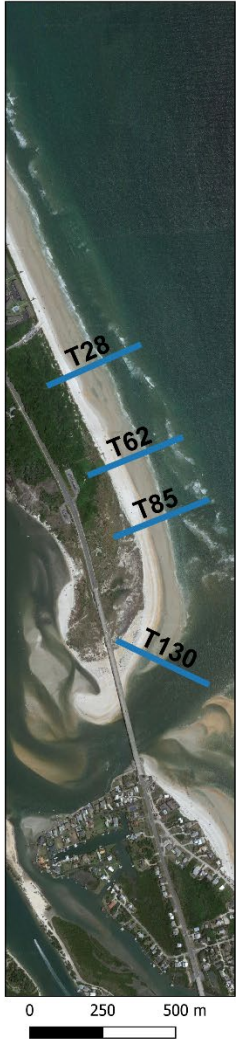
Hurricane Matthew



Distance (m)

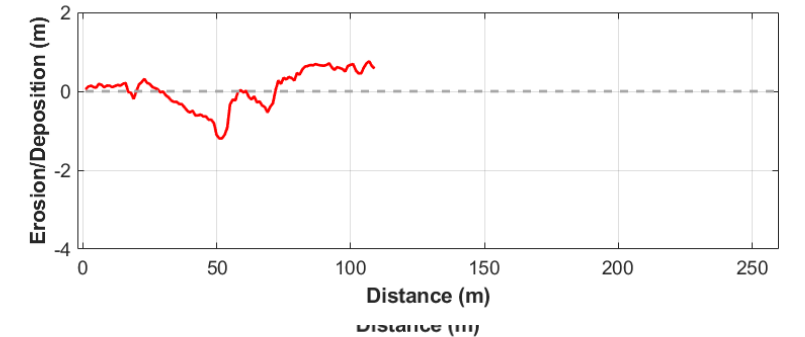
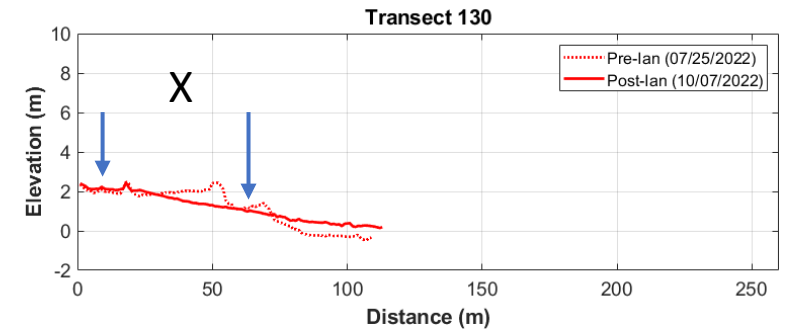
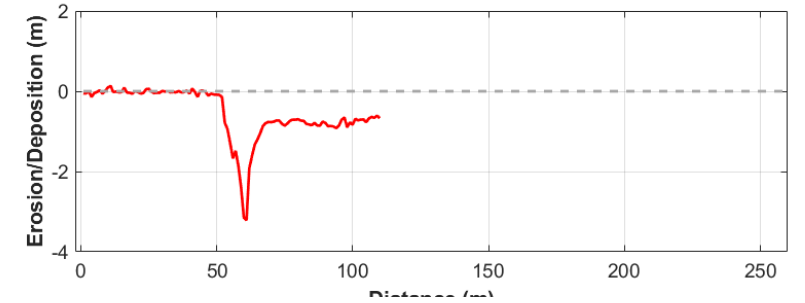
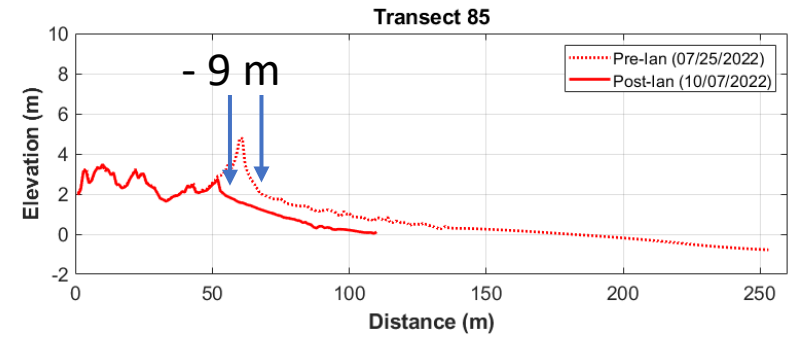
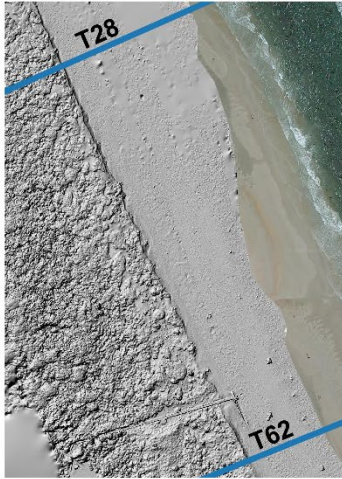
Results & Discussion

Hurricane Irma



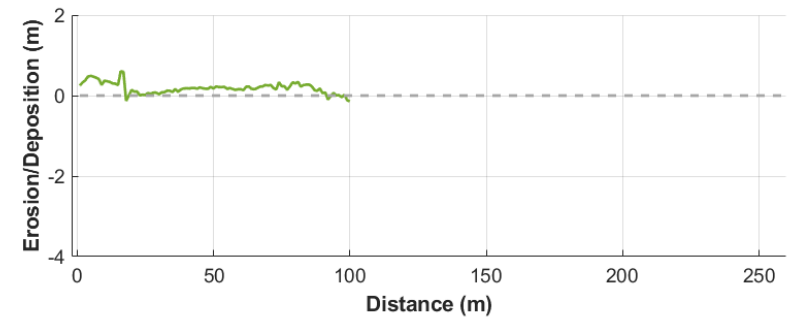
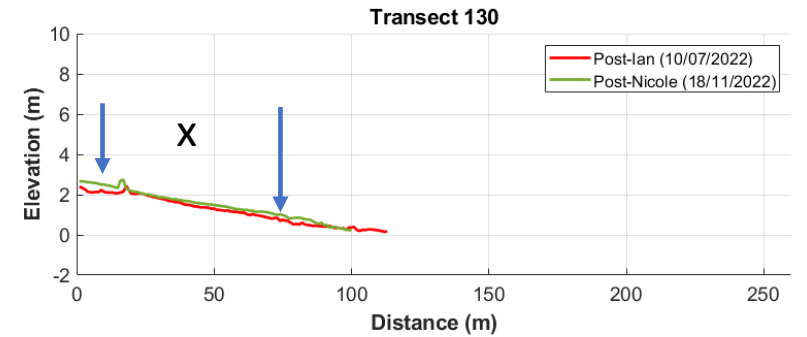
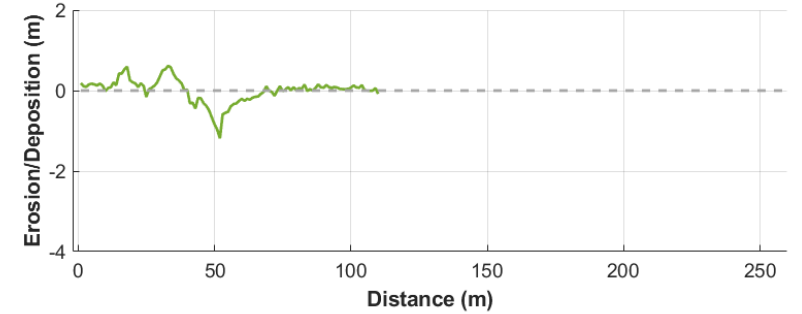
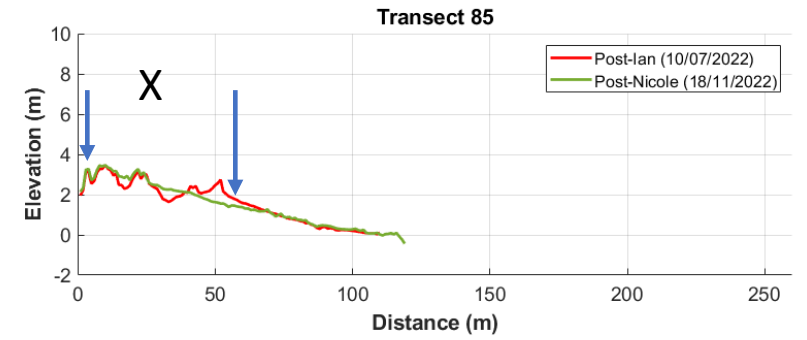
Results & Discussion

Hurricane Ian



Results & Discussion

Hurricane Nicole



Results & Discussion

Wave Conditions

Duration time

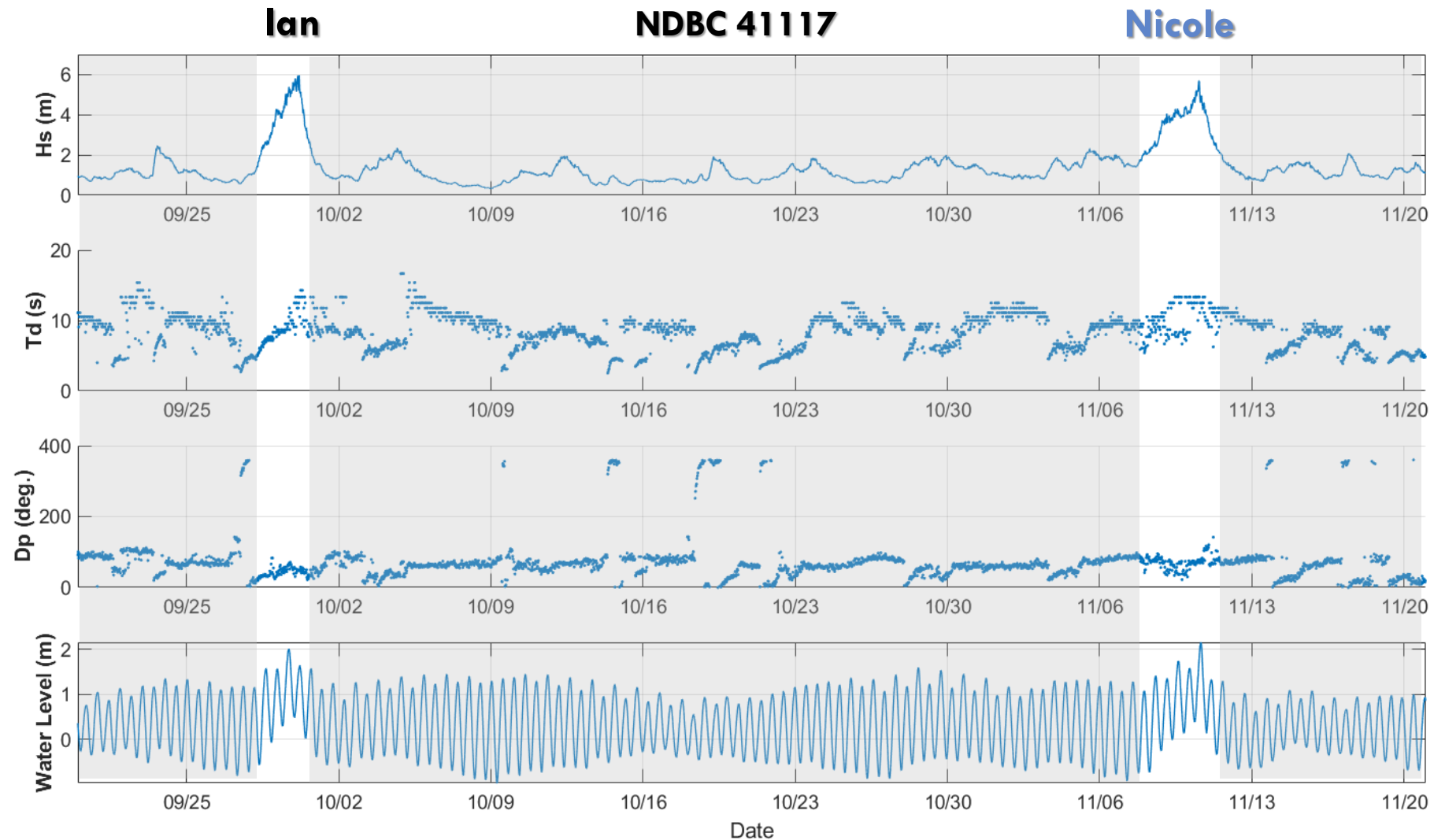
Ian – 2 days

Nicole - 3.5 days

Storm waves and elevated
water levels increased the

duration time for dune collision
during Nicole, as compared to

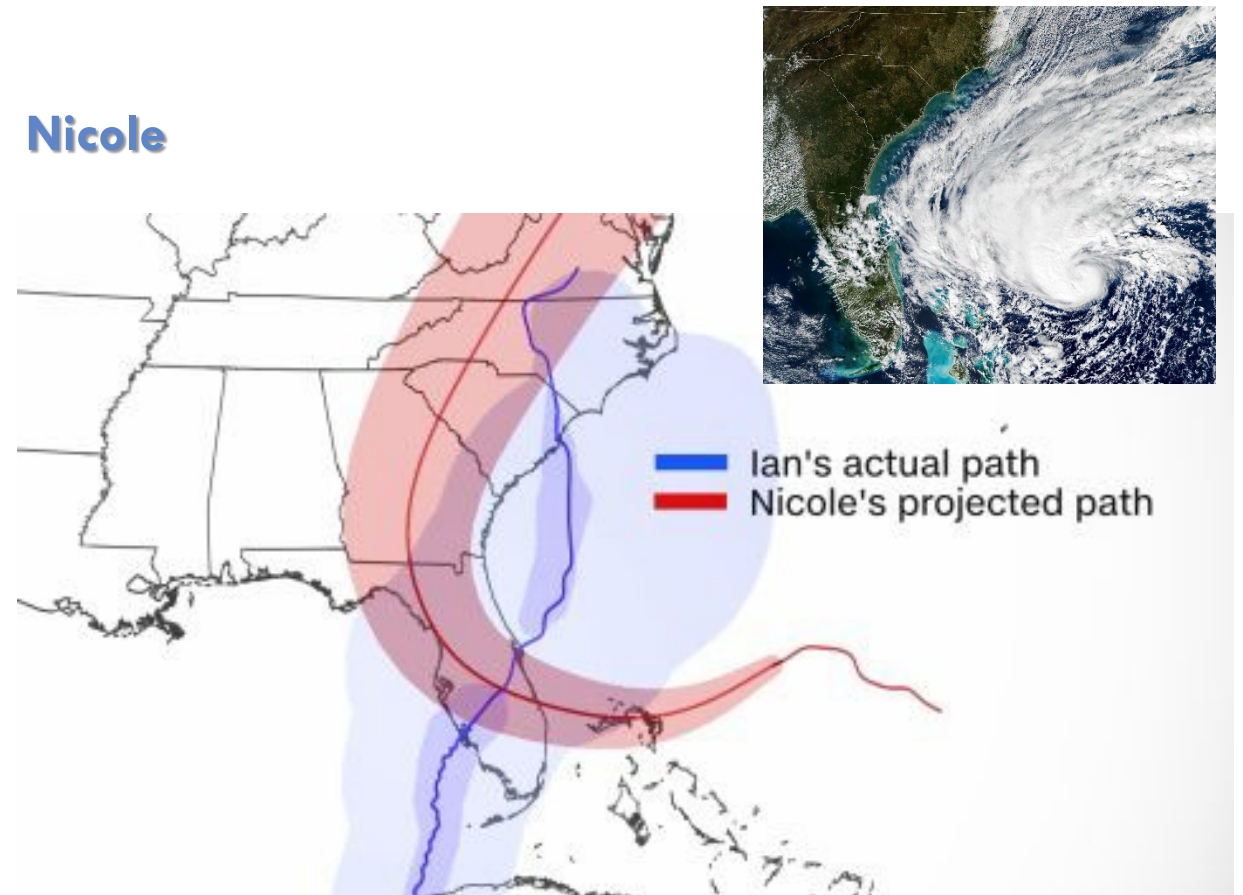
Ian



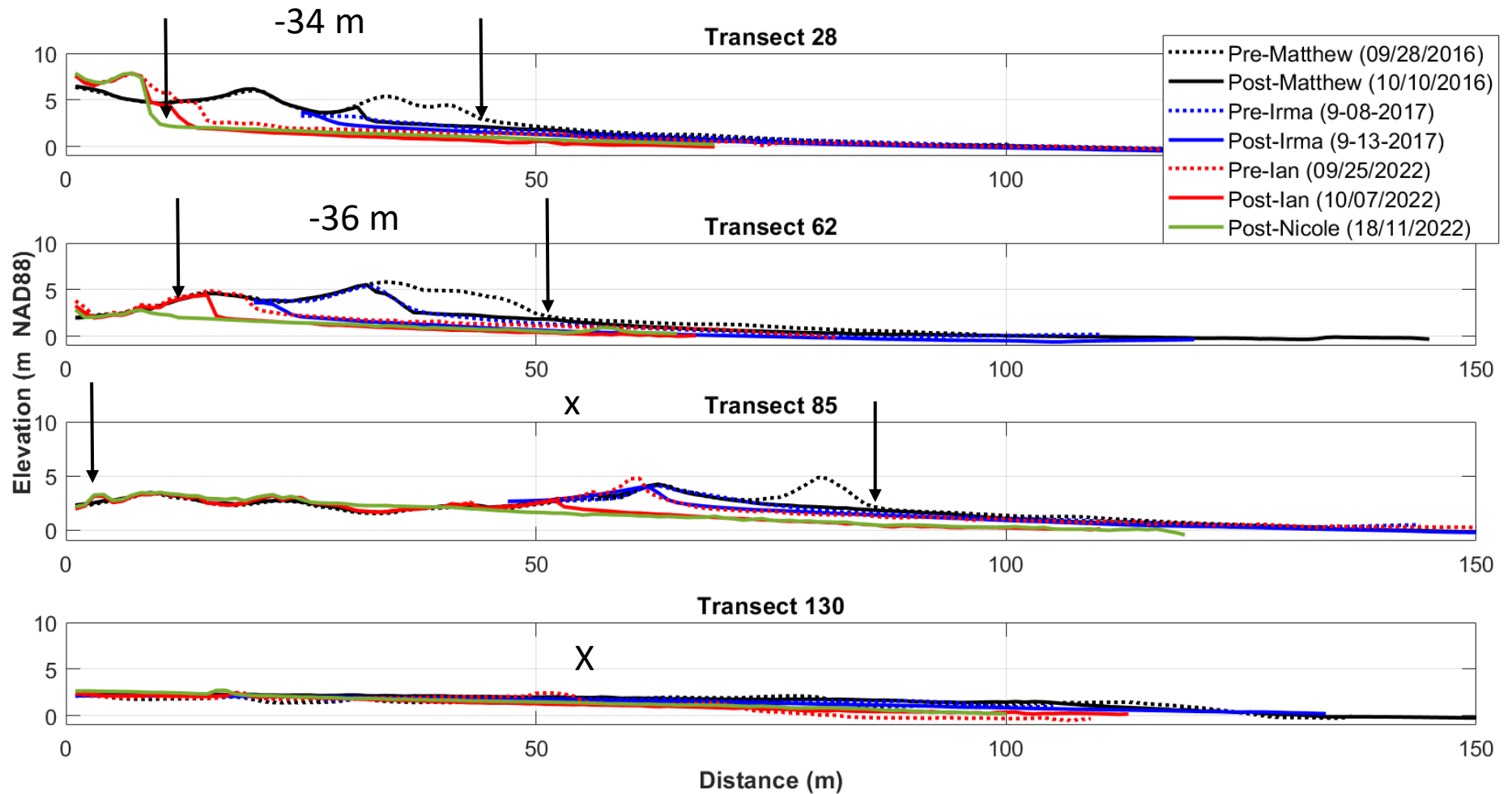
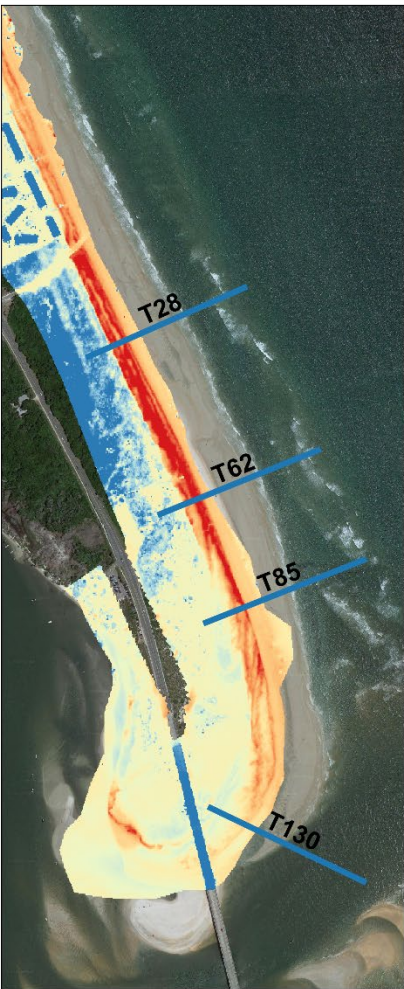
Results & Discussion

Hurricane Tracks

Duration differences could be attributed to the storm tracks




Results & Discussion 2016 - 2022



Conclusions

Hurricane Ian was one of the strongest to hit the U.S., but it did not produce the greatest dune retreat (erosion) at the Matanzas Inlet site.

Dunes adjacent to Matanzas Inlet are exhibiting a decadal trend of unidirectional landward migration, perhaps due to insufficient recovery time between storms



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THANK YOU

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